DOCUMENT RESUME

ED 138 777 CE 010 976

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TITLE Industrial Electronics. Performance Objectives. Basic Course.
INSTITUTION Duval County School Board, Jacksonville, Fla.
PUB DATE Jan 75
NOTE 81p.

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS *Behavioral Objectives; *Criterion Referenced Tests; Curriculum Guides; *Electronics; Senior High Schools; *Trade and Industrial Education

ABSTRACT

Several intermediate performance objectives and corresponding criterion measures are listed for each of 30 terminal objectives for a two-semester (2 hours daily) high school course in basic industrial electronics. The objectives cover instruction in basic electricity including AC-DC theory, magnetism, electrical safety, care and use of hand tools, electrical circuits, measuring devices, electric meters, transformer and controls, basic electrical motor and generator theory, and introduction to electronics. Titles of the 30 terminal performance objectives are the following: Course introduction, safety, hand tools, mathematics review, basic physics, basic circuits and components, conductors and insulators, resistance and resistors, D.C. measuring devices, D.C. circuit analysis, protective devices, magnetic fundamentals, electromagnetism and induction, basic meter movements, fundamentals of alternating current, introduction to A.C. mathematics, oscilloscope and signal generator operation, A.C. resistive circuits, inductors and inductance, capacitance and capicitators, inductive reactance and impedance, capacitive reactance and impedance, power in A.C. circuits, A.C. circuit analysis, series resonating circuits, parallel resonating circuits, principles of filters, transformers and transformer principles, dynamotors and converters and inverters and voltage regulators, and industrial electronics and the vacuum tube. (JT)

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ED138777

# INDUSTRIAL ELECTRONICS

## PERFORMANCE OBJECTIVES

BASIC COURSE

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ACKNOWLEDGEMENTS

This manual was developed using System Approach For Education (SAFE) guidelines.

Appreciation and recognition are extended to the following educators who have assisted in the preparation of this manual:

Mr. Bill Long, Coordinator

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Mr. Joseph Killough, Coordinator

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# INTRODUCTION

This course outline in Industrial Electronics is the result of an intensive effort on the part of local industrial instructors, supervisors and administrators in updating this curriculum.

The objective is to design, develop, validate and field test a course in Industrial Electronics for high school students. The attainment of satisfactory completion will be evidenced by 85% of the participants ability to achieve a level of 75% or better proficiency on all of the terminal objectives contained in this curriculum guide.

This course will be field tested throughout the current year of 1974-75 and any necessary revisions will be made.

INDUSTRIAL ELECTRONICS - BASIC

Accreditation No. 9323

Length of Course: 2 semesters

Time Block: 2 hours daily

COURSE DESCRIPTION

Includes instruction in: basic electricity including AC-DC theory, magnetism, electrical safety, care and use of hand tools, electrical circuits, measuring devices, electric meters, transformer and controls, basic electrical motor and generator theory and introduction to electronics.

# INDUSTRIAL ELECTRONICS (Basic)

Syllabus of Terminal Performance Objectives

0.0 Curriculum Objective
1.0 Course Introduction
2.0 Safety
3.0 Hand Tools
4.0 Mathematics Review
5.0 Basic Physics
6.0 Basic Circuits and Components
7.0 Conductors and Insulators
8.0 Resistance and Resistors
9.0 D. C. Measuring Devices
10.0 D. C. Circuit Analysis
11.0 Protective Devices
12.0 Magnetic Fundamentals
13.0 Electromagnetism and Induction
14.0 Basic Meter Movements
15.0 Fundamentals of Alternating Current
16.0 Introduction to A. C. Mathematics
17.0 Oscilloscope & Signal Generator Operation
18.0 A. C. Resistive Circuits
19.0 Inductors and Inductance
20.0 Capacitance and Capacitors
21.0 Inductive Reactance & Impedance
22.0 Capacitive Reactance & Impedance
23.0 Power in A. C. Circuits
24.0 A. C. Circuit Analysis
25.0 Series Resonating Circuits
26.0 Parallel Resonating Circuits
27.0 Principles of Filters
28.0 Transformers & Transformer Principles
29.0 Dynamotors, Converters, Inverters and Voltage Regulators
30.0 Industrial Electronics and The Vacuum Tube

## 0.0 Curriculm Objective

To develop, validate, field test, and revise a 1 year curriculm for Basic Industrial Electronics by August 1975. Successful completion of this objective will be evidenced by the validation of the contents by the Electronics Craft Advisory Committee in September 1974, the field testing of the contents during the 1974-75 school year and revision and re-printing of corrections by August 1975. Implementation of the final product will be the 1975-76 school year.

COURSE INDUSTRIAL ELECTRONICS - Basic

**TERMINAL PERFORMANCE OBJECTIVE NO.** 1.0 — COURSE INTRODUCTION

Following instruction on introductory information on the Course operating procedures the student will pass a teacher made examination with 75% or better accuracy.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 1.1 | Given a list of 20 Titles the student will select with 100% accuracy one title related to the field of electronics. | 1.1 | Circle those areas related to one electronic field:<br>(a) Truck Driver<br>(b) Service Manager<br>(c) Electronics Technician<br>(d) Installation Repairman<br>(e) Electronics Mechanic |
| 1.2 | The student will with 100% accuracy state the purpose of the course, the starting and ending times for the class and will list 10 subject areas to be covered in this course. | 1.2 | State one purpose of this course.<br>(a) State the starting and ending times for the class<br>(b) List 10 subject areas to be covered in this course. |
| 1.3 | With 100% accuracy the student will state the percentage for each given area of responsibility as it effects the final average. | 1.3 | Write the percentage that each of the following will weigh upon the final grade:<br>(a) Written work and note book<br>(b) Experiments<br>(c) Examinations<br>(d) Work projects<br>(e) Conduct |
| 1.4 | The student will describe the procedure for making up work missed and state 5 rules governing conduct in class and lab. | 1.4 | Describe the procedure for making up work missed.<br>(a) State 5 rules of conduct for class, room and laboratory.<br>(b) State 10 safety rules to be followed when using shop test equipment. |
| 1.5 | The student will with 80% accuracy state 10 safety rules concerning one use of shop test equipment. | 1.5 | State 10 safety rules to be followed when using shop test equipment. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 1.0 (cont'd) COURSE INTRODUCTION

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 1.6 | Given instructions in inventory systems the student will with 75% accuracy or better (on written exam) describe shop inventory system and means for maintenance of perpetual inventory. | 1.6 | Describe one shop inventory system.<br>a. Explain how perpetual inventory can be maintained. |
| 1.7 | The student will demonstrate his knowledge of student organizations available to him by answering 5 of 6 test questions. | 1.7 | What is VICA<br>a. What are its goals and objectives<br>b. List three activities that local members participate in.<br>c. How is VICA organized<br>d. How can you benefit from VICA.<br>e. What do you have to do to join VICA. |

EXAMINATION - SAFETY T.P.O. #2

1. In case of severe electric shock, artificial respiration is used to:
   a. start the heart beating
   b. prevent paralysis of the respiratory muscles
   c. prevent suffocation
   d. warm up the chest muscles

2. The brain and nervous system can be restored to normal function only if the air and blood circulation have not been stopped for longer than:
   a. four hours
   b. thirty minutes
   c. eight hours
   d. five minutes

3. Artificial respiration should be continued until:
   a. the body starts to cool
   b. natural breathing is restored or a medical authourty declares the patient dead.
   c. the onset of rigor mortis
   d. you think the patient is dead.

4. As soon as the victim has been removed from contact with an electric circuit:
   a. start artificial respiration
   b. check to see whether he is breathing
   c. make certain his mouth is open
   d. remove any object that shouldn't be in his mouth

5. After a severe electric shock, patients sometimes die after having been revived. This is due to:
   a. not apply artificial respiration soon enough
   b. giving the patient a stimulant
   c. not allowing the patient to get up
   d. the effects of shock or injury

6. Which of the following currents is the lowest that could be considered dangerous?
   a. 5 ma
   b. 12 ma
   c. 25 ma
   d. 100 ma

7. What value of voltage is defined as high voltage.
   a. 50 V
   b. 120 V
   c. 220 V
   d. 440 V

8. What percentage of hydrogen to air (by volume) is considered dangerous?
   a. 2%
   b. 3%
   c. 4%
   d. 5%

9. Which of the following agents should be used in combatting electrical fires?
   a. water
   b. chemical foam
   c. carbon tetrachloride
   d. carbon dioxide

10. Which of the following voltages is the deadliest in terms of numbers of persons electrocuted?

    a. 50 V
    b. 120 V
    c. 220 V
    d. 440 V

11. Before working on any circuit containing a capacitor, you should:
    a. check to see that the power switch is closed
    b. short the terminals of the capacitor
    c. clear the workroom of all other people
    d. have a form type fire extinguisher available for use.

12. A hazardous valtage is any voltage that is in excess of:
    a. 50 V
    b. 20 V
    c. 10 V
    d. 30 V

13. If you see smoke coming from an electronic appliance or instrument, the first thing you should do is:
    a. call the fire department
    b. use a fire extinguisher to control the fire
    c. deenergize the circuit
    d. pour water on the equipment

14. The safe way to lift heavy objects is to keep your back straight and use the strength of your legs to do one lifting.T or F

15. Watches and rings should be removed before starting to work around high voltage equipment. T or F.

COURSE INDUSTRIAL ELECTRONICS-Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 2.0

SAFETY

Following instruction on safety practices, the student will pass a teacher made examination with 75% accuracy or better.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 2.1 | The student will identify orally or in writing at least 5 safety regulations pertaining to electrical electronics. | 2.1 | Identify 5 safety regulations |
| 2.2 | The student with 100% accuracy will define the term "Safety Consciousness" | 2.2 | Define the term "Safety Consciousness" |
| 2.3 | The student will with 100% accuracy demonstrate the correct method of applying artificial respiration. | 2.3 | Demonstrate the correct method of applying artificial respiration. |
| 2.4 | The student will identify the correct definition of an electrical ground. | 2.4 | Select the correct definition of an electrical ground:<br>a. Protection for humans<br>b. Connection of the neutral wire to ground<br>c. Connection of a wire to earth |
| 2.5 | The student will state 4 of our 5 classes of fires and name the type of fire extinguisher for each. | 2.5 | State 4 classes of fires and name the type of fire extinguisher for each. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 3.0 HAND TOOLS

Upon completion of instruction on the use and care of hand tools 85% of the students will achieve 75% or better proficiency on a written criterion test and on given hand tool demonstration assignments.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 3.0 | Test attached |
| 3.1 | Given pictures of the commonly used hand tools in Electrical/Electronic work, the student will identify 75% of them in writing. | 3.1 | Identify in writing the hand tools listed on the test sheet. |
| 3.2 | Given the names of 8 common hand tools the student will describe in writing the safety precautions to be with 6. | 3.2 | State in writing the safety precautions of the following tools:<br>a. soldering gun<br>b. file<br>c. cold chisel<br>d. screwdriver<br>e. adjustable end wrench<br>f. diagonal pliers<br>g. heat sink<br>h. wire strippers |
| 3.3 | The student with 100% accuracy will identify and demonstrate the proper use of 4 types of punches. | 3.3 | Identify and demonstrate the proper use of the 4 punches assigned. |
| 3.4 | Given 4 questions involving soldering the student will answer 3 correctly. | 3.4 | Complete the following statements:<br>a. the two base metals in solder are _____ and _____.<br>b. the type of flux used for electronic work is _____.<br>c. the type of solder most commonly used is _____.<br>d. the best type of soldering tool for making connections in transistor circuits is _____. |

COURSE INDUSTRIAL ELECTRONICS -Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 3.0 (cont'd) HAND TOOLS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 3.5 | With 75% accuracy the student will:<br>a. state the reason for using flux in soldering work<br>b. list the steps, in order involved in soldering electrocal connections. | 3.5 | a. state the reason for using flux in soldering work<br>b. List the steps in order involved in soldering electrical connections |
| 3.6 | Following instructions involving safety when handling electrical circuits, and with the necessary job sheet materials, trainer and tools the student will with 75% accuracy solder electrical connections to the following standards:<br>a. mechanically secure<br>b. connect flux usage<br>c. connect usage of soldering device<br>d. proper solder joint | 3.6 | With the use of job sheet no. 3a solder electrical connections to the listed standards:<br>a. mechanically secure<br>b. connect flux usage<br>c. connect usage of soldering device<br>d. proper solder joint |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 4.0

MATHEMATICS REVIEW

Upon completion of the unit on Mathematics review, 90% of the students will achieve 75% or better proficiency on a teacher made examination.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 4.0 | Test attached |
| 4.1 | Given mathematical problems involving addition, subtraction, multiplication and division of whole numbers the student will solve 75% correctly. | 4.1 | Solve:<br>Add: 4 + 18 + 36 + 7<br>Subtract: 481 - 371<br>Multiply: 8 x 507<br>Divide: 180 ÷ 6 |
| 4.2 | Given four problems involving decimals, the student will solve three correctly. | 4.2 | Solve:<br>Add: .031 + 1.2<br>Subtract: 2.5 - 2.061<br>Multiply: 1.08 x .9<br>Divide: .04 ÷ .005 |
| 4.3 | Given four problems involving fractions the student will solve three correctly. | 4.3 | Solve:<br>Add: 3/4 + 218 + 67/8<br>Subtract: 91/16 - 71/8<br>Multiply: 25/16 x 13/8<br>Divide: 181/4 ÷ 31/8 |
| 4.4 | Given four problems involving percentages the student will correctly solve three. | 4.4 | Solve:<br>A. What percentage of 90 is 30?<br>B. What is 15% of 120?<br>C. What is 1% of 27?<br>D. If 2% = 5, what is 1%? |
| 4.5 | Given four problems involving square root the student will correctly solve three. | 4.5 | Solve:<br>A. Find the square root of 3170.<br>B. Square 27.<br>C. Divide the square root of 81 by the square root of 9.<br>D. Multiply the square of 12 by the square of 4. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 4.0 (cont'd)

MATHEMATICS REVIEW

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 4.6 | Given four problems involving exponents, the student will correctly solve three. | 4.6 | Solve:<br>A. $10^2 + 10^2$<br>B. Express 380 in standard form.<br>C. Express $1.8 \times 10^2$ into a whole number |
| 4.7 | Using the slide rule the student will solve three of the four given problems correctly. | 4.7 | Solve:<br>A. Square root of 1426<br>B. $108 \times 27$<br>C. $426 \div .03$<br>D. $1/4 \times 11/8$ |
| 4.8 | Given four problems involving algebraic problems, the student will solve three correctly. | 4.8 | Solve:<br>A. Add: $6x + (-18x)$<br>B. Subtract: $6x - (-18x)$<br>C. Multiply: $3a^2b^3 \times 4ab^3$<br>D. Divide: $\frac{-12a^3x^4y}{4a^2x^2y}$ |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 5.0

BASIC PHYSICS

Upon completion of this area of instruction 85% of the students will achieve 75% or better accuracy in defining terms associated with electron theory and will demonstrate the use of electromotive forces.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 5.1 | 1. Define 15 given terms<br>2. State the law of electrical changes.<br>3. List 5 methods for producing electricity and describe type of equipment used to produce each.<br>4. State the two requirements for current flow. | 5.1 | Define the following:<br>a. matter<br>b. elements<br>c. compounds<br>d. atom<br>e. molecule<br>f. proton<br>g. neutron<br>h. atomic number<br>i. valence shell<br>j. electron shell<br>k. conductor<br>l. insulator<br>m. semiconductor<br>n. static-electricity<br>o. dynamic electricity<br>p. coulomb<br>q. volt<br>r. ampere<br>s. resistance<br>t. power |
| 5.2 | Orally or in writing the student will define the terms voltage and polarity and apply the symbols and signs with 75% accuracy. | 5.2 | Define voltage and polarity and apply the symbols associated with the circuitry. |
| 5.3 | The student will identify and describe primary and secondary cells and explain their use with 75% accuracy. | 5.3 | Identify and describe:<br>a. Primary cells<br>b. Secondary cells<br>c. Explain use of each type of cell. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 5.0 (cont'd)

BASIC PHYSICS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 5.4 | Given the necessary job sheet, materials and test equipment, the student will construct a series and parallel circuit using the test equipment to analize the circuit and verify all calculated values with a minimum of 75% accuracy. | 5.4 | Construct a series and parallel circuit according to the job sheet. Calculate and verify all pertinent data about operation of each circuit as given on the job sheet. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 6.0

BASIC CIRCUITS AND COMPONENTS

Given Electrical Circuit terms 85% of the students will with 75% or better accuracy. Define and draw, give circuit diagrams, and will explain given laws of electricity.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 6.0 | Test Attached |
| 6.1 | Given a list of terms associated with electrical circuits the student will define 8 of the 10. | 6.1 | Define<br>a. electric circuits<br>b. power source<br>c. conductor<br>d. load<br>e. open circuit<br>f. short circuit<br>g. series connected circuits<br>h. parallel connected circuits<br>i. combination circuits |
| 6.2 | Given a list of 10 Electric Circuits components the student will draw the schematic symbol for 8. | 6.2 | Draw the schematic symbols for each of the following:<br>a. battery<br>b. generator<br>c. motor<br>d. conductors crossing, no connection<br>e. conductors crossing, connected<br>f. SPST Switch<br>g. fuse<br>h. circuit breaker<br>i. lamp<br>j. resistor |
| 6.3 | Given the following electric circuits the student using schematic symbols will draw each with 75% accuracy<br>a. series<br>b. parallel<br>c. combination | 6.3 | Use schematic symbols to draw examples of the following circuits.<br>a. series<br>b. parallel<br>c. combination |

COURSE INDUSTRIAL ELECTRONICS - Basic

**TERMINAL PERFORMANCE OBJECTIVE NO.** 7.0 — CONDUCTORS AND INSULATORS

T.P.O. Upon completion of this unit of instruction 85% of the students will achieve 75% or better proficiency on a demonstration and a criterion test.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 7.1 | Given a list of terms associated with conductors a and insulators the student will identify them with 75% or better accuracy | 7.0<br>7.1 | Test attached<br>Identify and define:<br>a. conductors<br>b. conductivity<br>c. resistivity<br>d. cross sectional area<br>e. circular mil area<br>f. specific resistance<br>g. temperature<br>h. insulation<br>i. voltage breakdown<br>j. dielectric constant<br>k. stranded wire<br>l. solid wire<br>m. megger |
| 7.2 | The student will with 75% accuracy:<br>a. explain the 4 factors affecting conductors<br>b. identify copper and aluminums position on the conductivity chart<br>c. change sqyaremil area to circular mil area of conductor<br>d. define the formula for specific resistance<br>e. explain the difference between positive, negative and zero temperature cofficient<br>f. name at least one type of material having positive negative and zero temperature cofficient capabilities. | 7.2 | The student will:<br>a. explain the 4 affecting conductors.<br>b. identify copper and aluminums'<br>c. change square mil area to circular mil area of a conductor<br>d. define the formula for specific resistance<br>e. explain the difference between positive and negative and zero temperature cofficient<br>f. name one type of material having positive, negative, and zero temperature cofficient capabibties. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 6.0 (cont'd) BASIC CIRCUITS AND COMPONENTS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 6.4 | Given incomplete Schematic Diagrams the student will complete the circuits on the diagrams with 75% accuracy. | 6.4 | Complete the following Circuits.<br>a.<br><br>b. |
| 6.5 | Given the names of electronic diagrams, the student will describe each and state its purpose. | 6.5 | Describe each of the following types of diagrams and state its purpose:<br>a. wiring diagram<br>b. block diagram<br>c. Schematic Diagram<br>d. Isometric Diagram |
| 6.6 | The student will state ohm's law and write the associated equations with 75% accuracy. | 6.6 | State ohm's law and write the 3 equations associated with that law. |
| 6.7 | The student will convert given common prefixes used with electrical units of measurements from one value to another with 75% accuracy. | 6.7 | a. 3 amps, equals _____ma.<br>b. .01 va equals _____ma.<br>c. .5kw equals _____watts<br>d. 20 kohms equals _____megohms |
| 6.8 | The student will with 75% accuracy state the law of power and write the associated equations. | 6.8 | State the Law of power and write the 3 equations associated with that law. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 7.0 (cont'd) CONDUCTORS AND INSULATORS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 7.3 | The student will identify 3 of 4 types of electrical conductors and state where they might be used. | 7.3 | Identify 4 types of electrical conductors and state where they are used. |
| 7.4 | Given two questions the student will explain the relationship between the physical size of a conductor and its resistance. | 7.4 | (a) If the cross - sectional area of a conductor is doubled, what happens to the resistance?<br>(b) If the length of a conductor is doubled what happens to the resistance? |
| 7.5 | The student will name the three best conductors of electricity. | 7.5 | Name the three best conductors for electricity. |
| 7.6 | Given a wire table the student will with 75% accuracy calculate the resistance of a specified size and length of copper wire. | 7.6 | Calculate the resistance of 8 feet to No. 22 copper wire at 68° F? |
| 7.7 | The student will identify 3 of 4 types of wire insulation and state where used. | 7.7 | Identify 4 types of wire insulation and state where used. |
| 7.8 | Given the required job sheet materials and tools the student will with 75% accuracy make the necessary wire splices and connections. | 7.8 | Make the necessary splices and electrical connections necessary to comply with job sheet No. 7a. |

COURSE INDUSTRIAL ELECTRONICS -- Basic

**TERMINAL PERFORMANCE OBJECTIVE NO.** 8.0

RESISTANCE AND RESISTORS

T.P.O. Upon the completion of this unit 85% of the students will achieve 75% or better proficiency by demonstration and criterion test.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 8.0 | Test attached. |
| 8.1 | Given a list of terms associated with resistance and resistors, the student will identify them with 80% accuracy. | 8.1 | Identify and Define:<br>a. resistance<br>b. conductance<br>c. positive temp. coefficient<br>d. negative temp. coefficient<br>e. ohm<br>f. resistor<br>g. tolerance<br>h. current rating<br>i. fixed resistor<br>j. adjustable resist or<br>k. variable resistor<br>l. potentiometer<br>m. rheostat<br>n. non-linear resistance<br>o. linear resistance |
| 8.2 | The student will with 75% accuracy<br>a. name the material that is used as a standard for conductor resistance.<br>b. name the three types of resistor construction<br>c. draw the correct symbol for fixed, adjustable and variable resistance.<br>d. draw a schematic diagram of a circuit with a rheostat connected to control load current. | 8.2 | The student will:<br>a. name the material used as a standard for conductor resistance.<br>b. name three types of resistor construction.<br>c. draw the symbol for a fixed, adjustable, and variable resistance.<br>d. draw a diagram of a circuit with a rheostat connected to control the current through a load. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 8.0 (cont'd) RESISTANCE AND RESISTORS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 8.3 | Given 20 resistors the student will use the color code to identify resistor values and tolerance with 75% accuracy. | 8.3 | Identify 20 resistors by the use of the color code and tolerance. |
| 8.4 | After instructions on the correct prodedure for using a multimeter to check resistance and given the necessary job sheet along with 10 specified resistors, the student will with 75% accuracy measure and identify each ones appropriate value. | 8.4 | With the use of job sheet No. 8a, and a multimeter, identify and measure 10 specified resistor values. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 9.0

D. C. MEASURING DEVICES

Upon completion of the study of D. C. Measuring Devices 85% of the students will achieve 75% or better proficiency by demonstration and criterion test.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 9.0 | Test attached |
| 9.1 | The student will demonstrate his knowledge of the basic D'Arsonval meter movement by explaining 4 of 5 given statements about meter movements. | 9.1 | Explain the following statements concerning the D'Arsonval metermovement<br>(a) construction<br>(b) effect current has when applied in wrong direction<br>(c) effect current has when applied in the correct direction<br>(d) sensitivity |
| 9.2 | The student will explain orally or in writing the terms parallax and interpolation. | 9.2 | Explain the terms parallax and interpolation. |
| 9.3 | The student will explain orally or in writing with 75% accuracy how the D'Arsonval meter movement can be used as a ammeter, how the meter range can be extended and how it is connected without damage to itself. | 9.3 | Explain how:<br>(a) The D'Arsonval meter movement can be used as an ammeter.<br>(b) to increase the range of an ammeter<br>(c) the ammeter is connected into the circuit without damage to itself. |
| 9.4 | The student will explain orally or in writing with 75% accuracy the D'Arsonval meter movement and how it can be used to measure voltage, how to extend meter range and the proper procedure when connecting it into an electrical circuit. | 9.4 | Explain how the D'Arsonval meter movement<br>(a) may be used as an ammeter<br>(b) voltage range can be extended<br>(c) as a volt meter is connected into the circuit. |
| 9.5 | The student will explain orally or in writing with 75% accuracy how the | 9.5 | Explain how the D'Arsonval meter movement<br>(a) may be used as an ohm meter<br>(b) utilizes batteries with the meter circuit |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 9.0 (cont'd) D. C. MEASURING DEVICES

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 9.5 cont | may be used to measure resistance, why a battery is used in the meter circuit and how the meter is connected into an electrical circuit without damage to itself. | 9.5 cont. | (c) is connected into a circuit for resistance readings. |
| 9.6 | The student will state 3 out of 4 safety precautions when using the D'Arsonval movement as a volt ohm meter (vom). | 9.6 | State 4 safety rules when using the VOM |
| 9.7 | The student will with 75% accuracy identify and explain the differences between VOM's and VTVM's . | 9.7 | Identify and explain the diffenence between VOM's and VTVM's. |
| 9.8 | Given the required job sheet, circuit board and materials, the student will connect and read all electrical measurements in the circuit using a multimeter, with 75% accuracy. | 9.8 | Using job sheet No. 9a make all electrical measurements on the circuit board provided using the multimeter. |

COURSE Industrial Electronics-Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 10.0 — D. C. Analysis

Upon completion of the unit on D.C. Analysis, 85% of the students will achieve 75% or better profeciency in D.C. circuit construction, testing and analysis as given in I.P.O. Criterim measures and will achieve 75% or better on a written criterim examination concerning D.C. circuit analysis.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 10.0 | Test Attached. |
| 10.1 | Given a list of four (4) possibles, the student will be able to identify the unit of measurement for "current and resistance" | 10.1 | The rate of electron flow is expressed in:<br>a. Volts<br>b. Ohms<br>c. Amperes<br>d. Power |
| 10.2 | With 75% accuracy orally or in writing the student will explain the terms voltage, current, resistance and power as they apply to:<br>a. Series D.C. circuits.<br>b. Parallel D.C. circuits.<br>c. Combination D.C. circuits. | 10.2 | Explain the terms current voltage resistance and power applicable to:<br>a. Series Circuits<br>b. Parallel Circuits<br>c. Combination Circuits |
| 10.3 | The student will with 75% accuracy explain Ohms Laws as they apply to series, parallel & combination D.C. circuit | 10.3 | Explain Ohms Laws as they apply to series, parallel, and combination D.C. Circuits. |
| 10.4 | Given a variety of circuit problems involving series, parallel and series-parallel circuits the student will solve 24 of 30 problems for unknown values. | 10.4 | See attached test. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 10.0 (cont'd) D. C. Circuit Analysis

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 10.5 | Following instructions on the operating procedure of multimeters and vacuum tube (VTVM) volt meters, and D.C. trainer, the student, using various values of resistors will correctly construct, and calculate the voltage current and power for a series D.C. circuit. | 10.5 | Construct a series circuit with various values of resistors. Calculate the voltage current and power using a multimeter and vacuum tube volt meter to verify calculations. |
| 10.6 | Using a multimeter, VTVM, and D.C. trainer, the student will correctly assemble and calculate the voltage current and power of various values of resistors, in: a parallel circuit. | 10.6 | Construct a parallel circuit with various values or resistors. Calculate the voltage, current and power using a multimeter an VTVM to verify calculations. |
| 10.7 | Using a multimeter, VTVM and D.C. trainer, the student will correctly assemble and calculate the voltage, current power for various values of resistors in a series parallel circuit. | 10.7 | Construct a series-parallel circuit with various values of resistors. Calculate the voltage, current and power using a multimeter and VTVM to verify calculation. |
| 10.8 | The student will correctly state Kirchoff's Laws for voltage and current. | 10.8 | Write the statements for Kirchoff's Law of:<br>a. voltage<br>b. current |
| 10.9 | Utilizing Kirchoff's Law the student will solve 8 of 10 problems involving series and parallel combination circuits. | 10.9 | See attached test. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 10.0 (cont'd) D. C. Circuit Analysis

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 10.10 | Given 10 problems involving bridge circuits and voltage dividers the student will solve 8 for the unknown values. | 10.10 | See attached test. |
| 10.11 | The student will correctly explain what is meant by power sound, internal resistance and illustrate in writing how it is figured into the over-all circuit. | 10.11 | Explain what is meant by power sound internal resistance and show by illustrations how it effects the over-all circuits operation. |
| 10.12 | With the use of a multimeter, VTVM and D.C. trainer, the student will correctly assemble a series resistor circuit, verify by experimentation and computation that the current flowing into the junction of an electric circuit is equal to the current leaving that same junction. | 10.12 | Construct a series resistive circuit with various resistor values. Verify by Kirchoff's Law that the current extending a junction is the same current leaving the junction. |

COURSE Industrial Electronics - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 11.0 — Protective Devices

Upon completion of this unit on Protective Devices 85% of the students will achieve 75% or better proficiency on a Criterion Test.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 11.0 | Test Attached. |
| 11.1 | Given a list of component parts the student will with 75% accuracy identify each by symbol and explain how each is used. | 11.1 | Identify by symbol and explain the use of:<br>a. Circuit Breakers<br>b. Switches<br>c. Pilot lamps<br>d. Fuzes<br>e. Interlock switches<br>f. Thermal switches<br>g. Overload relays<br>h. Contractors |
| 11.2 | The student will with 100% accuracy explain the difference between a control device and a protective device. | 11.2 | Explain the difference between a control device and a protective device. |
| 11.3 | The student will correctly list 4 devices that use the same method for determining current ratings. | 11.3 | List 5 devices that use the same methods for determining current ratings. |
| 11.4 | Given a list of switch designations, the student will identify four types of switches according to the number of poles and throws, explaining the meaning of the terms "make and break" | 11.4 | Identify each switch and explain the terms "make and break"<br>a. SPST<br>b. DPST<br>c. DPDT<br>d. SPDT |
| 11.5 | The student will draw the schematic symbols of four types of switches and will show how each may be used in a circuit. | 11.5 | Using four basic types of switches, draw the schematic symbol of each showing how each may be used in a circuit. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 12.0 — Magnetic Fundamentals

Upon completion of the unit on magnetic fundamentals 85% of the students will with 75% accuracy or better as determined by a criterion test, identify magnetic terms and circuits and demonstrate the use of the rules of magnetism.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 12.0 | Test attached. |
| 12.1 | Given a list of 15 terms associated with magnetism the student will define 10 or more. | 12.1 | Define the following:<br>a. Magnetic field<br>b. Magnetic poles<br>c. Magnetic flux<br>d. Permeability<br>e. Keeper<br>f. Saturation<br>g. Natural magnets<br>h. Artifical magnets<br>i. Reluctance<br>j. Retentivety<br>k. Residual magnetism<br>l. Ferromagnetic<br>m. Magnetostriction<br>n. Magnetic shielding<br>o. Diamagnetic |
| 12.2 | The student will correctly describe:<br>a. The law of magnetism<br>b. The molecular theory of magnetism | 12.2 | Describe the following:<br>a. The law of magnetism<br>b. The molecular theory of magnetism |
| 12.3 | The student will correctly define and explain the difference between magnetic materials and non-magnetic materials. | 12.3 | Define and explain the difference between magnetic and non-magnetic materials. |
| 12.4 | Given a variety of illustrations showing ring magnets, bar magnets, horseshoe magnets, | 12.4 | Draw the lines of force to illustrate the magnetic fields of:<br>a. Ring magnets<br>b. Bar magnets |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 13.0 (cont'd) Electromagnetism & Induction

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 13.6 | Given a list of 10 terms associated with electromagnetic induction the student will define 6 or more. | 13.6 | Define the following:<br>a. Field intensity<br>b. Electromagnetism<br>c. Induction<br>d. Magnetic core<br>e. Coil<br>f. Magnetomotive lance<br>g. Magnetic hystersis<br>h. Coil polarity<br>i. Motor action<br>j. Solenoid |
| 13.7 | The student will orally or in writing correctly identify Lenz's and Faraday's Law and explain their characteristics. | 13.7 | Identify Lenz's and Faraday's and explain their characteristics. |
| 13.8 | With 75% accuracy the student will draw and describe:<br>a. Electromagnetic induction<br>b. Magnitude of induced voltage<br>c. Basic motor action<br>d. Basic generating action | 13.8 | Draw and describe:<br>a. Generator action<br>b. Motor action |
| 13.9 | The student will define 4 of 5 terms about motors and generators. | 13.9 | Define:<br>a. Field poles<br>b. Armature<br>c. Slip rings<br>d. Commutator<br>e. Brushes |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 12.0 (cont'd) Magnetic Fundamentals

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 12.4 Con't | poles attracting and opposing, the student will illustrate the magnetic lines of force for 75% of the problems. | 12.4 | c. Horseshoe magnets<br>d. Poles attracting and opposing |
| 12.5 | Using bar, ring, horseshoe and flexable magnets the student will demonstrate by experimentate on the magnetic lines of force for 75% of the problem. | 12.5 | Using flexable bar, horseshoe and ring magnets. demonstrate the magnetic lines of force for each. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 13.0 — Electromagnetism and Induction

Upon completion of the unit on Electromagnetism, 85% of the students will achieve 75% proficiency or better on a criterion test and will demonstrate their ability to construct and test an electromagnetic device.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 13.0 | Test attached. |
| 13.1 | The student will correctly draw and describe 3 of 4 characteristics associated with a current carrying conductor within a magnetic field. | 13.1 | Draw and describe the magnetic field associated with:<br>a. straight wire<br>b. coiled wire<br>c. a rotating loop<br>d. a rotating loop conductor |
| 13.2 | The student will illustrate by demonstration the correct procedure for determing the direction of conductor motion, using the left hand rule. | 13.2 | Demonstrate the direction of conductor motion with the use of the left hand rule. |
| 13.3 | The student will explain 3 of the 4 factors needed to determine magnitude and polarity of an induced voltage. | 13.3 | Explain the 4 factors needed to determine magnitude and polarity of an induced voltage. |
| 13.4 | The student will explain 3 ways to increase the field strength of an electromagnet. | 13.4 | Explain 3 ways to increase the field strength of an electromagnet. |
| 13.5 | The student will orally or in writing correctly explain the term "ampere-turns" and how it effects the magnetizing force of magnetic materials. | 13.5 | Explain the term "ampere-turns" and its effect on magnetic materials. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 13.0 (cont'd) Electromagnetism & Induction

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 13.10 | Given the proper material and power supply the student will construct and demonstrate the operation of a solenoid. | 13.10 | Using magnetic wire, small iron core, a 1000 ohm relay and compass develop and demonstrate the operation of an electromagnetic solenoid. |

COURSE Industrial Electronics - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 14.0 — Basic Meter Movements

Upon completion of the unit of instruction on Meter Movements, 85% of the students will achieve 75% or better proficiency on a criterion test and one meter circuit construction and testing assignments as given in I.P.O. Criterion Measures.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 14.0 | Test Attached. |
| 14.1 | Given 5 types of meter movements the student will identify 4 types and describe the principle of operation of each:<br>a. Moving-coil<br>b. Moving-iron vane<br>c. Concentric vane<br>d. Moving plunger<br>e. Hot-wire | 14.1 | Describe the principle operation of the following movements:<br>a. Moving coil<br>b. Moving-Iron vane<br>c. Concentric VAne<br>d. Moving plunger<br>e. Hot-wire |
| 14.2 | Shown a picture of a typical meter movement the student will identify 7 of 9 meter parts which are common to most movements.<br>a. Coil<br>b. Pointer<br>c. Scale<br>d. Pivots<br>e. Bearings<br>f. Springs<br>g. Retaining pins<br>h. Zero Adjust screws<br>i. Clamping Mechanism | 14.2 | On a picture of a typical meter movement provided, identify the following parts:<br>a. Coil<br>b. Pointer<br>c. Scale<br>d. Pivots<br>e. Bearings<br>f. Springs<br>g. Retaining pins<br>h. Zero Adjust screws<br>i. Clamping mechanism |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 14.0 (cont'd) Basic Meter Movements

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 14.3 | Given a 50 microampere 100 ohmmeter movement, the student will correctly calculate the value of shunt resistance needed to extend the current range a specified value. | 14.3 | Using a 50 microampere movement having 100 ohms of resistance calculate the value of shunt resistance needed to extend the meter range to 100 milliamperes. |
| 14.4 | Given a 10 milliampere meter movement at 1000 ohms resistance the student will correctly calculate the value of multiplier resistance required to cause the meter range to be extended a specified value. | 14.4 | Calculate the value of multiplier resistance needed to extend the meter to read on the 0-25 volt range when using a 10 milliampere movement with 1000 ohms of resistance. |
| 14.5 | Given the necessary information about a specific meter movement and power supply the student will correctly calculate the values needed to use the movement as a series ohmmeter and shunt ohmmeter. | 14.5 | Using a 1 milliampere, 50 ohmmeter movements, calculate the value of limiting resistance needed on the R X 1 scale for both series and shunt type meter. |
| 14.6 | Given the following list of terms related to meters the student will define 15 of the 18:<br>a. Sensitivity<br>b. Galvanometer<br>c. Linear Scale<br>d. Non-linear Scale<br>e. Parallax<br>f. Damping<br>g. Calibration<br>h. Shunt<br>i. Multiplier<br>j. Multi-range<br>k. Zero Ohms adjust<br>l. Ohms per volt rating<br>m. Meter Loading<br>n. Clamp on Meter<br>o. Megger<br>p. Wattmeter<br>q. Rectifier | 14.6 | Define each of the following:<br>a. Sensitivity<br>b. Galvanometer<br>c. Linear Scale<br>d. Non-linear Scale<br>e. Parallax<br>f. Damping<br>g. Calibration<br>h. Shunt<br>i. Multiplier<br>j. Multi-range<br>k. Zero Ohms adjust<br>l. Ohm per volt rating<br>m. Meter Loading<br>n. Clamp on Meter<br>o. Megger<br>p. Wattmeter<br>q. Rectifier |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 14.0 (cont'd) Basic Meter Movements

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 14.7 | The student will orally or in writing correctly describe the method used to enable a moving coil meter to measure alternating current. | 14.7 | Describe the components and circuit used to enable the moving coil meter to measure alternating current. |
| 14.8 | Given the necessary component resistors, multimeter and multimeter circuit panel the student will with 75% accuracy demonstrate the procedure for extending the current range of a meter movement. | 14.8 | Using various component resistors, a multimeter, and multimeter circuit panel, show the procedure for extending the range of a current meter. |
| 14.9 | Given the necessary component resistors, multimeter circuit panel the student will with 75% accuracy demonstrate the procedure for extending the voltage range of a meter movement. | 14.9 | Using various component resistors, a multimeter and multimeter circuit panel demonstrate the procedure for extending the range of a volt meter. |
| 14.10 | Given various component resistor parts, or multimeter, multimeter circuit panel the student will with 75% accuracy demonstrate the procedure for extending the ohmmeter range of a meter movement. | 14.10 | Using various component resistors, a multimeter and multimeter circuit panel demonstrate the procedure for extending the range of ohmmeter. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 15.0 Fundamentals of Alternating Current

Upon completion of the unit of instruction on Fundamentals of Alternating Current, 85% of the students will achieve 75% or better proficiency on a written-----criterion test and assigned circuit problems.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 15.0 | Test attached. |
| 15.1 | Given a list of terms associated with alternating current the student will define them with 75% accuracy or better. | 15.1 | Define the following terms:<br>a. Pure D.C.<br>b. Fluctuating D.C.<br>c. Alternating Current<br>d. Line Wave<br>e. Square Wave<br>f. Non-sinusoidal<br>g. Lawtooth Wave<br>h. D.C. Component<br>i. D.C. Reference<br>j. Cycle<br>k. Hertz<br>l. Wavelength<br>m. Phase<br>n. Alternation<br>o. Period<br>p. Instantaneous<br>q. Average<br>r. Effective<br>s. R.M.S.<br>t. Frequency<br>u. Frequency Spectrum<br>v. Time |
| 15.2 | Given a list of terms associated with the frequency spectrum the student will define 8 correctly.<br>a. AF<br>b. VLF<br>c. LF | 15.2 | Define the following terms:<br>a. AF<br>b. VLF<br>c. LF<br>d. MF<br>e. HF<br>f. VHF<br>g. UHF |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 15.0 (cont'd) Fundamentals of Alternating Current

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 15.8 | Given the values, instantaneous, effective average and peak, the student will with 75% accuracy define each and illustrate how each of the 4 formulas applies to a sine wave of voltage or current. | 15.8 | Define instantaneous, effective, average and peak values. Illustrate how their formulas apply to a sine wave of voltage or current. |
| 15.9 | Knowing the peak value of an A.C. sine wave, the student will with 75% accuracy calculate the effective, average, instantaneous and peak values. | 15.9 | Calculate for the following values when given a source voltage having 100 volts peak.<br>a. Effective<br>b. Average<br>c. Instantaneous<br>d. Peak to peak |
| 15.10 | Shown an A.C. circuit problem involving only resistance the student will use ohms law and correctly solve for the unknowns. | 15.10 | An A.C. circuit has 141 volts (pk) applied to two 25 ohm resistors connected in series.<br>a. What is the effective current flow.<br>b. What is the average voltage drop across each resistor. |
| 15.11 | Given the formula for wave length and time, the student will correctly calculate the frequency and time of 300 meters. | 15.11 | Calculate the frequency and time of 300 meters. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 16.0 Introduction to A.C. Mathmatics

Upon completion of the unit on A.C. Mathmatics 85% of the students will achieve 75% or better proficiency on assigned A.C. Mathmatics problems.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 16.0 | Test attached. |
| 16.1 | Upon reviewing of algebraic equations the student will with 75% accuracy solve four various problems in addition, subtraction, multiplication, division and simple equations. | 16.1 | See attached quiz. |
| 16.2 | Given the equations, $XC = \frac{1}{2\ TT\ FC}$ and XL=2TTFI The student will correctly solve for XC and XL when F, L and C are given. | 16.2 | Find XC and XL when the below values are given:<br>F = 1000 Hz<br>C = 100 Microfarads<br>L = 30 Mahenries |
| 16.3 | Given the formula C2=a2+b2 the student will demonstrate his proficiency by correctly solving for C, A, and B on a criterion quiz. | 16.3 | See attached quiz. |
| 16.4 | Given, a right triangle with one unknown side, the student will use the pythagorean theorem to determine the length of the unknown side. | 16.4 | A right triangle has a base of 30 feet, altitude of 40 feet. What is the length of the hypotenuse. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 16.0 (cont'd) Introduction to A.C. Mathmatics

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 16.5 | Upon completion of instruction involving trigonometric functions, and given a drawing of a right triangle with only one side and one angle known, the student will use the correct functions for solving for the remaining sides and angles. | 16.5 | A right triangle has an angle 0 of 24 degrees, and an opposite side of 24 inches. Solve for the:<br>adjacent _____<br>hypotenuse _____<br>angle phi _____ |
| 16.6 | The student will correctly define a vector and illustrate how it is used in solving A.C. problems. | 16.6 | Define a vector and illustrate its use in solving A.C. problems. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 17.0 Oscilloscope & Signal Generator Operation

Upon completion of the unit on the oscilloscope and signal generator, 85% of the students will achieve 75% or better proficiency on a written criterion test and will set up and operate these pieces of equipment as given in the I.P.O. criterion measures.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 17.0 | Test attached. |
| 17.1 | Given a list of 12 controls related to oscilloscope the student will identify and explain the function of 8: | 17.1 | Identify and explain the function of the following oscilloscope controls:<br>a. Intensity-off<br>b. Focus<br>c. Horizontal Centering<br>d. Vertical Centering<br>e. Sweep Selector<br>f. Sweep Vernier<br>g. Sync.<br>h. Sync. Selector<br>i. Vertical Gain Selector<br>j. Vertical Gain Vernier<br>k. Horizontal Selector<br>l. Horizontal Gain Vernier |
| 17.2 | Given a drawing of the electron gun of a CRT tube the student will correctly identify and explain the use of 4 of it's 7 component parts. | 17.2 | Utilizing a drawing of a CRT tube, identify and explain how each component part works. |
| 17.3 | Using the face of a CRT tube, the student will show his understanding of the electron beams movement by making the correct adjustments to the horizontal and vertical plate controls. | 17.3 | Using an assigned oscilloscope adjust the horizontal and vertical plate controls to describe an A.C. sine wave on the CRT tubes face. |
| 17.4 | Upon completion of this unit the student will show his understanding of the oscil- | 17.4 | Using the oscilloscope, show with the controls that various:<br>a. The height of the wave form |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 17.0 (cont'd) Oscilloscope & Signal Generator Operation

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 17.4 | loscopes operation by correctly identifying and demonstrating the use of the controls that affect:<br>a. Height of the wave form.<br>b. Width of trace.<br>c. Brightness of trace.<br>d. Sharpness of trace.<br>e. Position of trace.<br>f. Steadiness of wave form. | 17.4 | b. Width of trace.<br>c. Brightness of trace.<br>d. Sharpness of trace.<br>e. Position of trace.<br>f. Steadiness of wave form. |
| 17.5 | The student will explain with 100% accuracy why a bright spot should never be left on the screen of a CRT tube. | 17.5 | Explain what happens if a bright spot is left too long on the face of a CRT tube. |
| 17.6 | After completion of this unit on signal generators the student will show his understanding by correctly identifying and demonstration the use of:<br>a. BFO Switch<br>b. Band Selector<br>c. Tuning Control<br>d. Calibrate Control<br>e. Signal Switch<br>f. Attenuator Control<br>g. Multiplier Level Switch<br>h. RF Out-put Terminal<br>i. Audio Out-put Terminal | 17.6 | With the use of the signal generator demonstrate the effect of the following controls:<br>a. BFO Switch<br>b. Band Selector<br>c. Tuning Control<br>d. Calibrate Control<br>e. Signal Switch<br>f. Attenuator Control<br>g. Multiplier Level Switch<br>h. RF Out-put Terminal<br>i. Audio Out-put Terminal |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 18.0

A.C. Resistive Circuits

Upon completion of the unit on A.C. resistive circuits, 85% of the students will achieve 75% or better proficiency on a written criterion test and or practice demonstrations as given in the I.P.O. criterion measures.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 18.0 | Test attached. |
| 18.1 | Following a review of Ohms Law the student will identify and explain the formulas for:<br>a. Voltage<br>b. Current<br>c. Resistance<br>d. Power | 18.1 | Identify and explain the following formulas:<br>a. Voltage<br>b. Current<br>c. Resistance<br>d. Power |
| 18.2 | Given a multimeter vacuum voltmeter (VTVM) and A.C. resistance board the student will demonstrate his proficiency by correctly assembling, calculating the voltage and current for various values of resistors for:<br>a. Series Circuits<br>b. Parallel Circuits<br>c. Series-parallel Circuits | 18.2 | Using a multimeter, vacuum tube, voltmeter (VTVM) and A.C. resistance circuit board, assemble, measure, and calculate the voltage and current for:<br>a. Series Circuit<br>b. Parallel Circuit<br>c. Series-parallel Circuit |
| 18.3 | Upon completion of this unit the student will demonstrate his proficiency with the use of an oscilloscope and VTVM by correctly measuring and calculating the voltage and current for various values of resistors for:<br>a. Series Circuits<br>b. Parallel Circuits<br>c. Series-parallel Circuits | 18.3 | Using an oscilloscope, VTVM, and A.C. resistance circuit board, assemble, measure, and calculate the voltage and current for:<br>a. Series Circuits<br>b. Parallel Circuits<br>c. Series-parallel Circuits |

COURSE Industrial Electronics-Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 17.0 (cont'd)

Oscilloscope & Signal Generator Operation

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 17.10 | Upon completion of this unit the student will demonstrate his proficiency by making correct oscilloscope adjustments for measuring frequencies of 60 cps., 120 cps., 500 cps., 1000 cps. | 17.10 | Using a suitable oscilloscope, direct probe signal generator variable A.C. power source and circuit patching unit, demonstrate the procedure for measuring 60 cps., 120 cps., 500 cps., and 1000 cps. |
| 17.11 | Upon completion of this unit, the student will demonstrate his proficiency making correct oscilloscope adjustments for measuring phase relationships of 0°, 45°, 90°, 135° and 180°. | 17.11 | Using a suitable oscilloscope, direct probe signal generator, variable A C power source and circuit patching unit, demonstrate the procedure for measuring: 0°, 45°, 90°, 135°, and 180°. |

COURSE Industrial Electronics-Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 17.0 (cont'd)

Oscilloscope & Signal Generator Operation

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 17.7 | The student will orally or in writing explain, with 75% accuracy:<br>a. How a signal is connected to an oscilloscope for observing wave forms.<br>b. How to calibrate the oscilloscope for use as an AC Voltmeter.<br>c. The procedure for finding an unknown frequency.<br>d. How to analize phase relationships. | 17.7 | Explain:<br>a. How a signal is connected to an oscilloscope for observing wave forms.<br>b. How to calibrate the oscilloscope for use as an AC voltmeter.<br>c. The procedure for finding an unknown frequency.<br>d. How to analize phase relationships. |
| 17.8 | Upon completion of this unit the student will demonstrate his proficiency by preparing the oscilloscope and signal generator to observe and read 7 of the 10 wave forms. | 17.8 | Using a suitable oscilloscope, direct probe, signal generator, multimeter and variable AC power source demonstrate the procedure necessary to observe and read voltage wave forms. |
| 17.9 | Upon completion of this unit the student will demonstrate his proficiency by correctly calibrating the oscilloscope using vacuum tube volt meters, internal calibrator and voltage values:<br>6 V.A.C.<br>12 V.A.C.<br>36 V.A.C. | 17.9 | Using a suitable oscilloscope, direct probe, signal generator, vacuum tube voltmeter and circuit patching unit demonstrate the procedure necessary for accurate calibration by measuring:<br>6 V.A.C.<br>12 V.A.C.<br>36 V.A.C. |

COURSE Industrial Electronics-Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 19.0

Instructors and Inductance

Upon completion of the unit on Inductance, 85% of the students will achieve 75% or better proficiency on a written criterion test and on inductive circuit constructing test, and analysis as given in the I.P.O. criterion measures.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 19.0 | Test Attached |
| 19.1 | The student will correctly define the term "inductance" and describe the effect it has on D.C and A.C. circuits. | 19.1 | a. What is Inductance?<br>b. State what happens to the voltage and current relationship when inductance is introduced into a:<br>(1) D.C. Circuit<br>(2) A.C. Circuit |
| 19.2 | The student will correctly state the measurement for inductance and list the factors that effect it. | 19.2 | a. Inductance is measured in _____.<br>b. List the factors effecting inductance. |
| 19.3 | Upon completion of this unit the student will identify and explain 7 of the 10 following statements:<br>a. Principles of inductance.<br>b. Factors affecting inductance, mathematically.<br>c. Energy stored in a magnetic Field.<br>d. Rise and FAll of resistor current.<br>e. Rise and Fall of Inductor current.<br>f. R.L. Time Constant mathematically.<br>g. Principles of mutual inductance.<br>h. Magnitude of induced voltage. | 19.3 | Identify and explain:<br>a. Principles of inductance.<br>b. Factors affecting inductance, mathmatically.<br>c. Energy stored in a magnetic field.<br>d. Rise and Fall of resistor current.<br>e. Rise and fall of inductive current.<br>f. R.L. time constant, mathmatically.<br>g. Principles of mutual inductance.<br>h. Magnitude of induced voltage.<br>i. Factors effecting induced voltage.<br>j. Cofficient of coupling, mathematically. |

COURSE Industrial Electronics-Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 19.0 (cont'd) Instructors and Inductance

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | i. Factors affecting induced voltage.<br>j. Cofficient of coupling, mathematically. | | |
| 19.4 | Given 10 problems involving inductors in series and parallel, the student will correctly solve 7. | 19.4 | Solve 10 problems involving inductors in series and parallel. |
| 19.5 | The student will correctly draw the symbols for the listed inductors and describe each:<br>a. Air Core<br>b. Iron Core<br>c. Insulated Core<br>d. non-inductive coil<br>e. Choke coils | 19.5 | Draw the symbols and describe the construction of the following inductors:<br>a. Air Core<br>b. Iron Core<br>c. Insulated core<br>d. non-inductive coil<br>e. Choke Coils |
| 19.6 | Upon completion of this unit the student will demonstrate his proficiency by correctly assembling the necessary coils. relays and resistors to show the effect D.C., and A.C. current has on the circuit. | 19.6 | Using a variable power source, multimeter, oscilloscope, assigned values of resistors, inductors and job sheet No. 19a, show the effect inductance has on D.C. and AC circuits. |
| 19.7 | Given the required job sheet, materials and test equipment the student will correctly assemble inductors in series to verify experimentally that inductance exists. | 19.7 | Using job sheet No. 19b , assigned. oscilloscope, miltimeters, various values of resistors and inductors verify that inductance exists in a series circuit. |

COURSE Industrial Electronics-Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 19.0 (cont'd) Instructors and Inductance

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 19.8 | Given the required job sheet, materials and test equipment the student will correctly assemble inductors in parallel to verify that inductance exists. | 19.8 | Using job sheet No. 19a, assigned oscilloscopes, multimeters various values of resistors and inductors verify that inductance exists in a parallel circuit. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 20.0 — Capacitance & Capacitors

Upon completion of the unit on Capacitance 85% of the students will achieve 75% or better proficiency on a written criterion examination and on given laboratory assignments as shown in the I.P.O. criterion measures.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 20.0 | Test attached. |
| 20.1 | The student will correctly describe the term "capacitance".and describe the effect it has upon a D.C. and A.C. circuit. | 20.1 | a. Define the term "capacitance".<br>b. State what happens to the voltage and current relationship when capacitance is introduced into a:<br>1) D.C. circuit<br>2) A.C. circuit |
| 20.2 | The student will correctly state the measurement for capacitance and list the factors effecting it. | 20.2 | a. Capacitance is measured in _____.<br>b. List the factors that effect capacitance. |
| 20.3 | Given 15 terms associated with capacitance the studant will define 11 correctly. | 20.3 | Define the following terms:<br>a. Plate<br>b. Dielectric<br>c. Electrostatic field<br>d. Charge<br>e. Negative plate<br>f. Positive plate<br>g. Dielecting constant<br>h. Farad<br>i. Microfarad<br>j. Picofarad<br>k. Electrolytic<br>l. Polarity<br>m. Disc<br>n. Tubular<br>o. D.C. voltage rating |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 20.0 (cont'd) Capacitance & Capacitors

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 20.9 | Given 10 problems involving capacitors in series and parallel the student will solve six correctly. | 20.9 | Solve ten problems involving capacitors in series and parallel. |
| 20.10 | Given instruction on the operation of a capacitor tester and the necessary job sheet, various types and values of capacitors and multimeter, the student will correctly identify each type of capacitor and demonstrate the procedure for:<br>a. checking value of capacitance<br>b. amount of leakage<br>c. power factor<br>d. shorts | 20.10 | With the use of job sheet no. 20a and assigned test equipment assorted values, of capacitors, check for their capacitance, leakage power factor and shorts. |
| 20.11 | Given the required job sheet, power supply, oscilloscope, capacitance tester, multimeter and various assigned values of resistors and capacitors, the student will correctly make the necessary connections for series and parallel circuits. Verify that the total capacitance may be increased or decreased depending upon the circuit connections. | 20.11 | Using job sheet no. 20b assigned test equipment and various values of capacitors and resistors measure, compute and record for:<br>a. series capacitive circuit<br>b. parallel capacitive circuit |

COURSE INDUSTRIAL ELECTRONIC (BASIC)

**TERMINAL PERFORMANCE OBJECTIVE NO.** 21.0 — Inductive Reactance & Impedance

Upon completion of the unit on Reactance and Impedance, 85% of the students will achieve 75% or better on a written examination and on assigned circuit construction problems as given the I.P.O. criterion measures.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 21.0 | Test attached. |
| 21.1 | Given a list of ten terms associated with inductive reactance and impedance the student will define eight correctly. | 21.1 | Define the following terms:<br>a. Inductive reactance<br>b. RL circuit<br>c. Impedance<br>d. True power<br>e. Apparent power<br>f. Power factor<br>g. RL time constant<br>h. "Q" of a coil<br>i. "Z"<br>j. Frequency response |
| 21.2 | The student will, with 75% accuracy explain the relationship between inductance, frequency and the applied voltage, showing the vector relationship. | 21.2 | Explain the relationship between inductance, frequency and applied voltage and the vector relationship between inductive voltage and applied voltage. |
| 21.3 | Given the value of the coil and frequency of the circuit the student will use the correct formula for determining the inductive reactance. | 21.3 | Compute the inductive reactance of a one henry coil when used with a frequency of 100 $H_z$. |
| 21.4 | The student will correctly explain the relationship between inductive reactance and | 21.4 | Explain the following relationship:<br>a. If the frequency is increased what happens to the inductive reactance. |

COURSE INDUSTRIAL ELECTRONIC (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 21.0 (cont'd) Inductive Reactance & Impedance

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 21.4 Con't | b. What happens to the inductance when the requency is increased. |
| 21.5 | Given two formulas for pure inductive circuits the student will correctly identify and explain how each is solved. | 21.5 | Identify and explain how each formula is solved.<br>a. $XLT = XL_1 + XL_2 + \text{----} + \text{etc}$<br>b. $\frac{1}{XLT} = \frac{1}{XL_1} + \frac{1}{XL_2} + \frac{1}{XL_3} + \text{----} + \text{etc}$ |
| 21.6 | Given 5 problems involving coils in series and parallel, the student will solve for total reactance of 4. | 21.6 | Solve for the total inductive reactance of 5 problems in series and parallel configuration. |
| 21.7 | The student will correctly explain the relationship between current and voltage in a series inductive-resistive circuit. | 21.7 | Explain the relationship between current and voltage in a series, inductive resistive circuit. |
| 21.8 | Upon review of trigonometric function the student will correctly identify and explain the three functions associated with A.C. theory. | 21.8 | Identify and explain the function of each formula:<br>a) $S = \frac{0}{H}$<br>b) $C = \frac{A}{H}$<br>c) $T = \frac{0}{A}$ |
| 21.9 | Using the three trigonometric functions the student will illustrate the correct procedure for computing series R. L. problems. | 21.9 | Calculate the phase angle and impedance of a circuit having a coil of 20 ohms XL in series with a resistance of 30 ohms. Show all computations. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 21.0 (cont'd)

Inductive Reactance & Impedance

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 21.10 | Given a series RL circuit problem, the student will analize the operation of the circuit, calculate all pertinent data and determine the effect of frequency change in the circuit, with 75% accuracy. | 21.10 | A 10 henry coil and a 1000 ohn resistor connected in series across a 200 volt 50 Hz power supply calculate the following:<br>a) $I_T$<br>b) $E_R$<br>c) $E_L$<br>d) $X_L$<br>e) Z<br>f) Pf.<br>g) phase angle |
| 21.11 | Given the required job sheet, circuit board VTVM, multimeter and assigned values of resistors and inductors, the student will construct a series RL circuit, using the test equipment to analize and verify all calculated values at 75% accuracy. | 21.11 | Construct a series RL circuit according to job sheet no. 21a using assigned test equipment calculate and verify all pertinent data concerning the circuits operation. |
| 21.12 | The student will accurately explain the operation of a parallel circuit utilizing inductors and resistors and resistors and illustrate the phase relationship between voltage and current across each component part. | 21.12 | Explain the operation of a parallel circuit and show the relationship between voltage and current across each component part. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 21.0 (cont'd) Inductive Reactance & Impedance

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 21.13 | Using the three trigonometric functions, the student will illustrate the correct procedure for computing parallel R.L. problems. | 21.13 | Calculate the phase angle and impedance of a parallel circuit whose values are:<br>a. Circuit D.C. resistance of 20 ohms<br>b. Circuit D.C. resistance of 50 ohms |
| 21.14 | Given a parallel R.L. circuit problem the student will analize the operation of the circuit calculate all pertinent data and determine the effect of frequency in the circuit with 75% accuracy. | 21.14 | A 100 ohm resistor is connected in parallel with a 10 henry coil across a 100 volt 60 Hz power supply, calculate the values of:<br>a. $I_T$<br>b. $I_R$<br>c. $I_L$<br>d. $X_L$<br>e. $\bar{Z}$<br>f. Pf<br>g. Phase angle |
| 21.15 | The student will correctly define the "Q" of a circuit and show the relationship between $X_L$ and R of the circuit. | 21.15 | Define the "Q" of a circuit and show its relationship between circuit reactance and resistance. |
| 21.16 | Given the required job sheet, circuit $B_O$ and, VTVM, multimeter and assigned values of resistors and inductors, the student will construct a parallel R.L. circuit using the test equipment to analize and verify all calculated values at 75% accuracy. | 21.16 | Construct a parallel R.L. circuit according to job sheet no. 21b using assigned test equipment, calculate and verify all pertinent data concerning the circuits operation. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 21.0 (cont'd) Inductive Reactance & Impedance

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 21.17 | Given values of resistance and inductance in a circuit the student will determine the R.L. time constant and calculate the current rise, with 75% accuracy. | 21.17 | A 2 henry coil is connected in series with a 10 ohm resistor. What is the R.L. time constant and how long will it take the current to reach maximum value. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

**TERMINAL PERFORMANCE OBJECTIVE NO.** 23.0 — Power in A.C. Circuits

Upon completion of the unit on power in A.C. circuits 85% of the students will achieve 75% or better on a written criterion exam and on assigned circuit problems as given in the I.P.O. criterion measures.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 23.0 | Test attached. |
| 23.1 | Following a review of power in a D.C. circuit given a list of terms associated with A.C. power the student will identify all term with 75% accuracy. | 23.1 | Identify the following terms:<br>a. True power<br>b. Apparent power<br>c. Reactive power<br>d. Average power |
| 23.2 | The student will with 75% accuracy draw and explain the phase relationship of current, voltage and power in inductive and capacitive circuits. | 23.2 | Draw and explain the wave forms showing phase relationship of current, voltage and power in a:<br>a. Purely resistive circuit<br>b. Purely inductive circuit<br>c. Purely capacitive circuit<br>d. Resistive inductive circuit<br>e. Capacitive resistive circuit |
| 23.3 | The student will correctly define the unit of measurement for:<br>a. True power<br>b. Apparent power<br>c. Reactive power<br>d. Power factor | 23.3 | Define the unit of measurement for:<br>a. True power<br>b. Apparent power<br>c. Reactive power<br>d. Power factor |
| 23.4 | The student will orally or in writing with 75% accuracy describe the relationship of the power factor to the phase angle of a circuit. | 23.4 | Describe the relationship of the power factor to the phase angle of a circuit. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 23.0 (cont'd) — Power in A.C. Circuits

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 23.5 | The student will with 100% accuracy, write the formulas required to complete:<br>a. True power (PT)<br>b. Apparent power (PA)<br>c. Power factor (PF) | 23.5 | Write the formulas required to compute:<br>a. True power<br>b. Apparent power<br>c. Power factor |
| 23.6 | The student will with 75% efficiency, explain how the PF indicates circuit efficiency. | 23.6 | Explain how the power factor (PF) indicates circuit efficiency. |
| 23.7 | Given a circuit containing resistors, capacitors, and inductors the student will correctly calculate the values of PR, PT, PA, PF and indicate whether the power factor is leading or lagging. | 23.7 | A 50 ohm resistor, an inductor of 180 ohms and capacitive reactance of 150 ohms is connected across a 100 volt power source. Calculated for:<br>a. PR<br>b. PA<br>c. PT<br>d. PF<br>e. Leading or lagging power factor |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 24.0 — A.C. Circuit Analysis

Upon completion of the unit on A.C. circuit analysis 85% of the students will achieve 75% on a written criterion examination and will construct, test and analyze given A.C. circuits.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 24.0 | Test attached. |
| 24.1 | Upon completion of this unit and review of LR and CR series circuits, the student will correctly:<br>a. Define a series LCR circuit.<br>b. Explain how voltage drops are added in a series L.C.R. circuit.<br>c. Show how resistances combine in a series L.C.R.<br>d. Illustrate how the total impedance is found and whether or not the circuit has a leading or lagging power factor. | 24.1 | The student will:<br>a. Define a series L.C.R. circuit.<br>b. Explain how voltage drops are additive in a series L.C.R. circuit.<br>c. Show how resistances combine in a series L.C.R.<br>d. Illustrate how the total impedance is found and the power factor phase angle. |
| 24.2 | Given 5 L.C.R. series problems the student will correctly solve 4 for:<br>a. I total<br>b. $\bar{Z}$<br>c. $I_R$<br>d. $I_C$<br>e. Exc<br>f. ExL<br>g. Phase angle<br>h. True power<br>i. Reactive power | 24.2 | Solve 5 L.C.R. series problems for the following values:<br>a. I total<br>b. $\bar{Z}$<br>c. $I_R$<br>d. $I_C$<br>e. $E_{XC}$<br>f. $E_{XL}$<br>g. Phase angle<br>h. True power<br>i. Reactive power<br>j. Apparent power |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 24.0 (cont'd) A.C. Circuit Analysis

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 24.2 Con't | j. Apparent power<br>k. Circuit efficiency | 24.2 | k. Circuit efficiency |
| 24.3 | Given the required job sheet, power supply, circuit board ocilloscope, VTVM, signal generator and assigned values of capacitors, resistors and inductors the student will construct a series L.C.R. circuit using the test equipment to analize and verify all calculated values with 75% accuracy. | 24.3 | Construct a series L.C.R. circuit according to job sheet no. 24a, using assigned test equipment calculate and verify all pertinent data concerning the circuits operation. |
| 24.4 | The student will with 75% accuracy:<br>a. Define a parallel L.C.R. circuit.<br>b. Explain how voltage drops are additive in a parallel L.C.R. circuit.<br>c. Show how resistances combine in a parallel L.C.R. circuit.<br>d. Illustrate how the total impedance is found and whether or not the circuit has a leading or lagging power factor. | 24.4 | The student will:<br>a. Define a parallel L.C.R. circuit.<br>b. Explain how voltage drops are additive in a parallel L.C.R. circuit.<br>c. Show how resistances combine in a parallel L.C.R.<br>d. Illustrate how the total impedance is found and the power factor phase angle. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 24.0 (cont'd) — A.C. Circuit Analysis

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 24.5 | Given 5 L.C.R. parallel problems the student will correctly solve 4 for:<br>a. I total<br>b. Z<br>c. $I_R$<br>d. $I_C$<br>e. $E_{xc}$<br>f. $E_{xL}$<br>g. Phase angle<br>h. True power<br>i. Reactive power<br>j. Apparent power<br>k. Circuit efficiency | 24.5 | Solve 5 L.C.R. parallel problems for the following values:<br>a. I total<br>b. Z<br>c. $I_R$<br>d. $I_C$<br>e. $E_{xc}$<br>f. $E_{xL}$<br>g. Phase angle<br>h. True power<br>i. Reactive power<br>j. Apparent power<br>k. Circuit efficiency |
| 24.6 | Given the required job sheet, power supply circuit board, oscilloscope, VTVM, signal generator and assigned values of capacitors, resistors and inductors the student will construct a parallel L.C.R. circuit using the proper test equipment to analize and verify all calculated values, with 75% accuracy. | 24.6 | Construct a parallel L.C.R. circuit according to job sheet no. 24b, using assigned test equipment calculate and verify all pertinent data concerning the circuits operation. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 25.0 Series Resonanting Circuits

Upon completion of the unit on series resonanting circuits 85% of the students will achieve 75% or better proficiency on a criterion test and will demonstrate their ability by constructing a resonanting circuit and with the use of test equipment verify that the circuit will resonant when the proper frequency is applied.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 25.0 | Test attached. |
| 25.1 | The student will correctly define a series resonant circuit. | 25.1 | Define a series resonant circuit. |
| 25.2 | The student will correctly explain what happens when the source frequency is applied to a series resonant circuit. | 25.2 | Explain what happens to a series circuit when the source frequency is:<br>a. Above the resonant frequency.<br>b. Equal to the resonant frequency.<br>c. Below the resonanting frequency. |
| 25.3 | The student will identify and describe 4 of the 5 terms and what effect they have on the resistance of a series resonanting circuit. | 25.3 | Identify and describe what effect the following terms has on the resistance of a series resonanting circuit. |
| 25.4 | The student will correctly label the current and impedance curves of a series resonanting circuit. | 25.4 | Label the current and impedance curves of a series resonanting circuit. |
| 25.5 | Given a list of conditions the student will identify those that exist in a series resonant circuit with 75% accuracy. | 25.5 | Identify the below listed conditions that exist in a series resonant circuit:<br>a. Phase angle is 90 degrees.<br>b. Phase angle is 0 degrees.<br>c. Impedance is maximum.<br>d. Circuit is minimum.<br>e. Impedance equals resistance. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 25.0 (cont'd) Series Resonanting Circuits

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 25.5 | f. PA is greater than PT.<br>g. PT equals PA.<br>h. Current is maximum.<br>i. Power factor is one.<br>j. XC is equal to XL. |
| 25.6 | Given the formula for a series resonanting circuit the student will solve 4 out of 5 circuit problems. | 25.6 | Using the series resonanting formula solve 5 problems. |
| 25.7 | Given the terms band pass circuit and band reject circuit, the student will identify each and explain their use with 75% accuracy. | 25.7 | Identify and explain the use of a<br>a. Band pass circuit.<br>b. Band reject circuit. |
| 25.8 | The student will list and describe 3 out of 4 applications for a series resonanting circuit. | 25.8 | List and describe 4 applications of a series resonanting circuit. |
| 25.9 | Given the necessary job sheet, circuit training board, materials and test equipment the student will construct a series resonant circuit. He will calculate the voltage, current, and the impedance by using the appropriate test equipment to verify calculations with 75% accuracy. | 25.9 | Using job sheet No. 25a, circuit board assigned materials and test equipment set up and test a series resonanting circuits for voltage, current and impedance verifying the values by the use of test equipment. |
| 25.10 | Given the necessary job sheet circuit training board materials and test equipment the student will with 75% accuracy construct a series resonanting circuit and verify by the use of test equipment and calculations that the circuit Q and band widths are effected by frequency. | 25.10 | With the use of a job sheet No. 25b circuit board, assigned materials and test equipment, set up a series resonanting circuit and verify by calculation that circuit Q and band width is affected by frequency. |

COURSE INDUSTRIAL ELECTRONICS - Basic

**TERMINAL PERFORMANCE OBJECTIVE NO.** 26.0

PARALLEL RESONANTING CIRCUITS

Upon completion of the unit dealing with Parallel Resonanting Circuits 85% of the students will achieve 75% or better on a criterion test and will demonstrate their ability by constructing a resonant circuit and with the use of test equipment verify that the circuit will resonant when the proper frequency is applied.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 26.0 | Test equipment |
| 26.1 | The student will define 5 of 7 terms associated with parallel resonant circuits. | 26.1 | Define the following terms:<br>a. parallel resonance<br>b. tank circuit<br>c. circulating current<br>d. damped waves<br>e. infinite impedance<br>f. Q of the circuit<br>g. band reject |
| 26.2 | The student orally or in writing will state the function of live current in a parallel resonant circuit with 75% accuracy. | 26.2 | Orally or in writing state the function of the live current in a parallel resonant circuit. |
| 26.3 | Given a list of conditions the student will list those that exsist in a parallel resonant with 75% accuracy. | 26.3 | Identify the below listed conditions that exsist in a parallel resonant circuit.<br>a. L and C are in parallel<br>b. phase angle is 90 degrees<br>c. voltage is connected in parallel across L and C.<br>d. XL and XC are equal at the resonant frequency<br>e. circulating current is minimum at resonance<br>f. impedance is maximum at resonance |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 26.0 (cont'd) PARALLEL RESONANTING CIRCUITS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 26.4 | The student will correctly select a parallel circuit from a group of circuit diagrams. | 26.4 | Identify the circuit listed below that satisfies a parallel resonant condition. |
| 26.5 | Given a set of frequency curves for a parallel resonant circuit the student will identify and label:<br>a. the impedance curve<br>b. current response curve<br>c. voltage curve | 26.5 | Identify and label on a parallel resonant frequency curve the listed indications:<br>a. impedance curve<br>b. current response curve<br>c. voltage curve |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE OBJECTIVE NO. 26.0 (cont'd) PARALLEL RESONANTING CIRCUITS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 26.6 | Given the term "off resonance" the student will explain if this condition is a result of an increase or decrease in frequency of the applied voltage. | 26.6 | Explain how the term "off resonance" is a results of an increase or decrease of the applied voltage frequency. |
| 26.7 | Given a parallel resonant circuit problem the student will with 75% accuracy calculate the voltage current impedand band width and circuit Q. | 26.7 | A 6.4 millihenry 5 ohm coil is connected in parallel with a 20 mfd capacitor across a 200 volt, 100 cycle power supply. Calculate the following:<br>a. resonant frequency<br>b. XL<br>c. XC<br>d. IL<br>e. IC<br>f. Z<br>g. circuit Q<br>h. band width |
| 26.8 | The student will correctly describe how parallel resonant resistance effects:<br>a. resonant frequency<br>b. I line<br>c. band width<br>d. Q of circuit<br>e. power factor | 26.8 | Describe how the below listed terms is effected by the circuit resistance of a parallel resonant circuit<br>a. resonant frequency<br>b. I line<br>c. band width<br>d. Q of circuit<br>e. power factor |
| 26.9 | The student will list and describe two applications for a parallel resonant circuit with 75% accuracy. | 26.9 | Name two applications of a parallel resonant circuit and describe the operation of each. |
| 26.10 | Given the necessary job sheet, circuit training board, materials and test equipment the student will with 75% accuracy construct a parallel resonant circuit, calculate impedance, voltage and current, and with the use of test equipment verify the calculations. | 26.10 | With the use of job sheet no. 26a, circuit board, assigned materials and test equipment set up and test a parallel resonant circuit for voltage current and impedance verifying the values by the use of test equipment. |

COURSE INDUSTRIAL ELECTRONICS - Basic

TERMINAL PERFORMANCE
OBJECTIVE NO. 26.0 (cont'd) PARALLEL RESONANTING CIRCUITS

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 26.11 | Given the necessary job sheet, circuit training board, materials, and test equipment the student will with 75% accuracy construct a parallel resonant circuit and verify by the use of calculations and test equipment that the applied frequency effects the circuit Q and band width. | 26.11 | With the use of job sheet no. 26b, circuit board, assigned material and test equipment, set up a parallel resonant circuit and verify by calculations and test equipment the frequency affects circuit Q and band width. |

COURSE Industrial Electronics (Basic)

TERMINAL PERFORMANCE
OBJECTIVE NO. 27.0 Principles of Filters

Upon completion of the unit on filters 85% of the students will achieve 75% proficiency on a criterion test and will be about to identify and test given types of filter networks with 85% accuracy.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 27.0 | Test attached. |
| 27.1 | Upon review of AC circuit analysis, the student will correctly define inductance and capacitance explaining their operating principles with 75% accuracy. | 27.1 | Define and explain the terms:<br>a. Inductance<br>b. Capacitance. |
| 27.2 | Orally or in writing, the student will correctly explain how AC current can be combined with DC current. | 27.2 | Explain how AC current can be combined with DC current. |
| 27.3 | The student will illustrate by drawings, how AC sugnals can be coupled from one circuit to another with 75% accuracy. | 27.3 | Illustrate by drawings how AC signals are coupled from one circuit to another. |
| 27.4 | The student will correctly describe the process where by audio frequencies can be seperated from radio frequencies. | 27.4 | Describe the process involved for seperating audio frequencies from audio frequencies. |
| 27.5 | The student will correctly identify and explain the use of:<br>a. Law pass filter.<br>b. High pass filter.<br>c. Series Resonant filter.<br>d. Parallel resonant filter. | 27.5 | Identify and explain the use of:<br>a. Law pass filter<br>b. High pass filter<br>c. Series resonant filter<br>d. Parallel resonant filter<br>e. Band pass filter<br>f. Band reject filter<br>g. power line filters<br>h. Antenna filters<br>i. wave trap filter |

COURSE Industrial Electronics (Basic)

TERMINAL PERFORMANCE OBJECTIVE NO. 27.0 (cont'd) Principles of Filters

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 27.5 | (con't)<br>e. Band pass filter.<br>f. Band reject filter<br>g. Power line filter<br>h. antenna filters<br>i. Wave trap filter | | |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

**TERMINAL PERFORMANCE OBJECTIVE NO.** 28.0 Transformer & Transformer Principles

Upon completion of the unit on transformer principles, 85% of the students will achieve 75% proficiency on a criterion test and will identify transformer types, their action and construction and will set up and test a power transformer with given test equipment.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 28.0 | Test attached |
| 28.1 | Given a schematic drawing of a simple transformer the student will correctly label the primary and secondary coil. | 28.1 | Label the primary and secondary winding of a simple transformer. |
| 28.2 | One student will with 75% accuracy:<br>a. Explain the term coefficient of coupling.<br>b. Explain phase relationship between the primary and secondary winding. | 28.2 | Explain:<br>a. The term coefficient of coupling.<br>b. Phase relationship between the primary and secondary winding. |
| 28.3 | The student will correctly explain the relationship:<br>a. Between voltage and turns ratio<br>b. Between power in the primary winding and power in the second any winding.<br>c. Between current and turns ratio. | 28.3 | Explain the relationship between:<br>a. Voltage and turns ratio.<br>b. Power in the primary winding and power in the secondary winding.<br>e. Current and turns ratio.<br>d. Impedance and turns ratio. |
| 28.4 | The student will draw the symbols for air-core and iron-core inductors and correctly describe each. | 28.4 | a. Draw the symbol for an air-core inductor and describe its construction.<br>b. Draw the symbol for an iron-core inductor and describe its construction. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 28.0 (cont'd) Transformer & Transformer Principles

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 28.5 | Given 16 terms associated with transformers the learner will define 12 of them. | 28.5 | Define the following terms:<br>a. Mutual inductance<br>b. Coefficient of coupling<br>c. Transformer<br>d. Secondary<br>e. Step-up<br>f. Step-down<br>g. Turns ratio<br>h. Primary<br>i. Reflected impedance<br>j. Power transformer<br>k. Hysteresis<br>l. Copper losses<br>m. Saturation<br>n. Auto transformer<br>o. Laminated core |
| 28.6 | Given a list of transformer characteristics, the student will match at least 4 out of 5 with either a step-up or step down transformer. | 28.6 | Identify the listed transformers characteristics with either a step-up or step down transformer<br>a. Higher primary current than secondary<br>b. Higher primary voltage than secondary<br>c. Lower secondary voltage than primary<br>d. Lower secondary current than primary<br>e. Higher secondary voltage than primary |
| 28.7 | The student will with 75% accuracy define:<br>a. Two general types of transformer losses.<br>b. Two types of core losses.<br>c. Purpose of lamination cores in transformers<br>d. Audio frequency transformers | 28.7 | Define:<br>a. Two types of transformer losses.<br>b. Two types of core losses.<br>c. Purpose of transformer core laminations.<br>d. Audio frequency transformers. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 28.0 (cont'd) Transformer & Transformer Principles

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 28.8 | Given the coefficient of coupling formula the student will correctly calculate the K of two coils. | 28.8 | Two coils having a mutual inductance of 40 m h each would have a K of:<br>a. .1<br>b. .01<br>c. 1.01<br>d. 1.11 |
| 28.9 | Shown an illustration of a transformer, given the primary and secondary winding turns ratio with applied voltage and a 100 ohm secondary load resistor the student will determine the current flow through the load. | 28.9 | An iron-core transformer with a 10.1 turns ratio has 10 volts at 10 amps applied to the primary winding. What would beethe value of current plan through the secondary winding if there was a 100 ohm load? |
| 28.10 | Given a symbol drawing of a power transformer the student will correctly label each color coded tapped wire and explain its connections when connecting into a load. | 28.10 | Identify the wire color coding of a power transformer. Explain how each lead is connected into a load. |
| 28.11 | Given the necessary job sheet, VTVM materials, power source, power transformer, VTVM, and multimeter the student will determine the power transformers, turns ratio calculate the effect of current increase in the secondary winding and learn the procedure for resistant testing. | 28.11 | With the use of job sheet no. 28a assigned test equipment and materials make the necessary connections to the power transformer calculate the turns ratio, effect of secondary current increase and resistant measurement of the windings vertifying the computations with the test equipment. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 29.0

Dynamotors, Converters, Inverters and Voltage Regulators

Upon completion of the unit dealing with devices converting energy by mechanical or electrical means 85% of the students will achieve 75% proficiency by demonstrating their knowledge of dynamotors, converters, inverters and voltage regulators on a criterion test.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 29.0 | Test attached. |
| 29.1 | The student will identify and explain the purpose of 4 of the 5 devices:<br>a. motor<br>b. converter<br>c. inverter<br>d. dynamotor<br>e. voltage regulator | 29.1 | Identify and explain the purpose of the 5 devices:<br>a. motor<br>b. converter<br>c. inverter<br>d. dynamotor<br>e. voltage regulator |
| 29.2 | Given a pictorial drawing of a D.C. motor showing the direction of current in the armature the student will indicate the direction of rotation of the armature. | 29.2 | Using a pictorial drawing of a D.C. motor show the direction of armature rotation when armature current direction is known. |
| 29.3 | Orally or in writing the student will give the correct name of the device used to change the direction of current in the armature of a D.C. motor. | 29.3 | State the name of the device used to change the direction of armature current in a D.C. motor. |
| 29.4 | Given three statements the student will select the statement that correctly describes the action taken by a carbon pile voltage regulator to compensate for | 29.4 | Select the statement that describes the action of a carbon pile voltage regulator needed to compensate for a change in engine speed or load. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 28.0 (cont'd) Transformer & Transformer Principles

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 28.12 | The student will identify and explain the use of the following transformers with 75% accuracy:<br>a. Power transformer<br>b. Autotransformer<br>c. Input transformer<br>d. Interstage transformer<br>e. Output transformer<br>f. R.F. transformer<br>g. I.F. transformer<br>h. Isolation transformer<br>i. Current transformer | 28.12 | Identify and explain the use of:<br>a. Power transformer<br>b. Autotransformer<br>c. Input transformer<br>d. Interstage transformer<br>e. Output transformer<br>f. R.F. transformer<br>g. I.F. transformer<br>h. Isolation transformer<br>i. Current transformer |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 29.0 (cont'd) Dynamotors, Converters, Inverters and Voltage Regulators

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 29.4 Con't | a change in engine speed or load. | | |
| 29.5 | The student will correctly describe the circuit condition necessary to cause the contacts of a reverse current relay to close. | 29.5 | Describe the circuit condition needed to cause the contacts of a reverse current relay to close. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 30.0 Industrial Electronics and The Vacuum Tube

Upon completion of this unit on introduction to electronics and the vacuum tube 85% of the students will achieve 75% or better proficiency on a criterion test.

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 30.0 | Test attached. |
| 30.1 | Given a list of developments and events associated with electronics, the student will start with the telegraph and continuing up through the development of solid state devices numbering them in order of their occurance with 75% accuracy. | 30.1 | Number in sequence the following events:<br>a._____ Development of the diode tube<br>b.<br>b._____ Intellegence transmitted across space<br>c._____ First radio<br>d._____ First transmission of electromagnetic energy across space<br>e._____ FCC established<br>f._____ Development of the triode tube<br>g._____ Development of first semiconductor<br>h._____ First television in color<br>i._____ Voice sent across space |
| 30.2 | Given two lists one on development and events, the other containing names of individuals. The student will with 75% accuracy match the individual to the event. | 30.2 | Match the name of the individual to the correct event:<br>1. Developed the triode tube<br>2. First transmission of intelligence<br>3. First television camera<br>4. Voice transmission<br>5. Cathode ray tube |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. ~~30.0~~ (cont'd) Industrial Electronics and The Vacuum Tube

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| | | 30.2 Con't | 6. First patent for television system<br>7. First photo cell<br>8. Exsistance of a magnetic field<br>a. Zworykin<br>b. Fleming<br>c. DeForest<br>d. Rasing<br>e. May<br>f. Faraday<br>g. Fessendon<br>h. Marconi<br>i. Braun<br>j. Edison |
| 30.3 | Given two lists, one on developments and events, the other containing names of individuals associated with the events and developments, the student will correctly match the name to each development. | 30.3 | Match the date to its corresponding event.<br>1. First transmission of electromagnetic energy through space<br>2. Intelligence transmitted across space<br>3. Development of the triode tube<br>4. First television camera<br>5. FCC established<br>6. Voice transmission<br>7. Diode tube development<br>8. First color television<br>9. First cathode ray tube<br>a. 1892 f. 1923<br>b. 1896 g. 1926<br>c. 1904 h. 1946<br>d. 1906 i. 1906<br>e. 1914 |
| 30.4 | The student will demonstrate knowledge of the principles involved in the Edison effect by defining 4 of the 5 terms. | 30.4 | Define the following terms. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 30.0 (cont'd) Industrial Electronics and The Vacuum Tube

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 30.4 Con't | a. A battery<br>b. B battery<br>c. anode<br>d. filament<br>e. plate | 30.4 Con't | a. A battery<br>b. B battery<br>c. anode<br>d. filament<br>e. plate |
| 30.5 | The student will correctly name the 4 methods of electron emission. | 30.5 | List 4 methods of electron emission |
| 30.6 | The student will name 4 of the 5 terms of atomic structure of matter.<br>a. planetary electrons<br>b. atomic theory<br>c. atomic number<br>d. atomic weight<br>e. valence | 30.6 | Define the following terms.<br>a. planetary electrons<br>b. atomic theory<br>c. atomic number<br>d. atomic weight<br>e. valence |
| 30.7 | The student will correctly write the basic function of any vacuum | 30.7 | State the basic function of any vacuum tube and how they are classified. |
| 30.8 | Given 5 uses of vacuum tubes the student will explain 6 of them. | 30.8 | Explain the following uses of vacuum tubes.<br>a. rectification<br>b. amplification<br>c. oscillation<br>d. waveshaping<br>e. electron emission<br>f. transit time |
| 30.9 | The student will orally or in writing correctly list and explain the four types of emission. | 30.9 | Correctly list and explain the four types of emission. |

COURSE INDUSTRIAL ELECTRONICS (BASIC)

TERMINAL PERFORMANCE OBJECTIVE NO. 30.0 (cont'd) Industrial Electronics and The Vacuum Tube

| NO. | INTERMEDIATE PERFORMANCE OBJECTIVES | NO. | CRITERION MEASURES |
|---|---|---|---|
| 30.10 | Given a schematic drawing of a vacuum tube the student will label the component parts with 75% accuracy. | 30.10 | Using a schematic drawing of vacuum tube, label its component parts. |
| 30.11 | The student will demonstrate his knowledge of metals used in tubes by listing 3 metals used in making thermonic emitters. | 30.12 | List 3 metals most widely used in making thermonic emitters. |
| 30.13 | The student will correctly:<br>a. List 3 characteristics of pure tungsten as an emitter material.<br>b. List 3 advantages of thoriated tungstenas an emitter metal compared to pure tungsten.<br>c. List 2 advantages that oxide-coated cathodes have over pure tungsten and thoriated tungsten. | 30.14 | a. List 3 characteristics of pure tungsten as an emitter material.<br>b. List 3 advantages of thoriated tungsten as an emitter metal compared to pure tungsten.<br>c. List 2 advantages that oxide coated cathodes have over pure tungsten. |
| 30.14 | The student will draw a pictorial diagram of:<br>a. Directly heated cathode<br>b. Indirectly heated cathode | 30.14 | Draw pictorial diagrams of:<br>a. Directly heated cathode<br>b. Indirectly heated cathodes |